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(54) Method and apparatus for producing a molten puddle during scarfing

(57) The method comprises the steps of igniting the fuel gas — oxygen mixture; heating a steel wire with the resultant flame to a temperature of from 900 to 1,450°C; and feeding the hot wire in a stepwise manner into a flow of scarfing oxygen, accompanied by the formation of droplets of molten metal to be transferred by the flow of scarfing oxygen onto the surface of a metal workpiece being scarfed.

Apparatus for carrying the method into effect comprises a housing 1 having ducts 7 and 6 for feeding a fuel gas and oxygen, respectively, said ducts being formed around the housing periphery; an additional duct 4 for feeding a fuel gas, said duct extending axially of the housing 1; a duct 2 for feeding a steel wire 3, disposed inside the additional duct 4 in coaxial arrangement therewith and a duct 5 for feeding scarfing oxygen interposed between the ducts 6 and 4. The duct 5 for feeding scarfing oxygen is made in the form of a convergent slot or ring of apertures arranged so as to permit the flow of scarfing oxygen to strike the surface of steel wire at one point thereof.

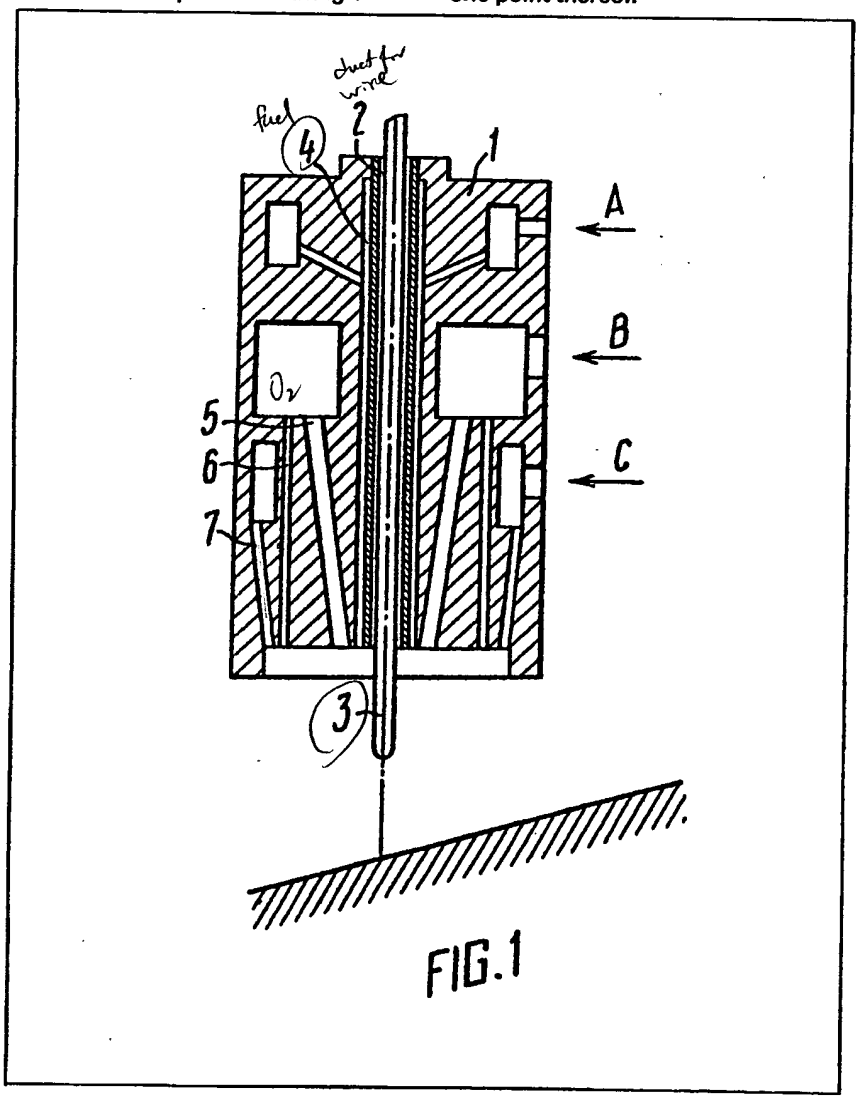

FIG.1

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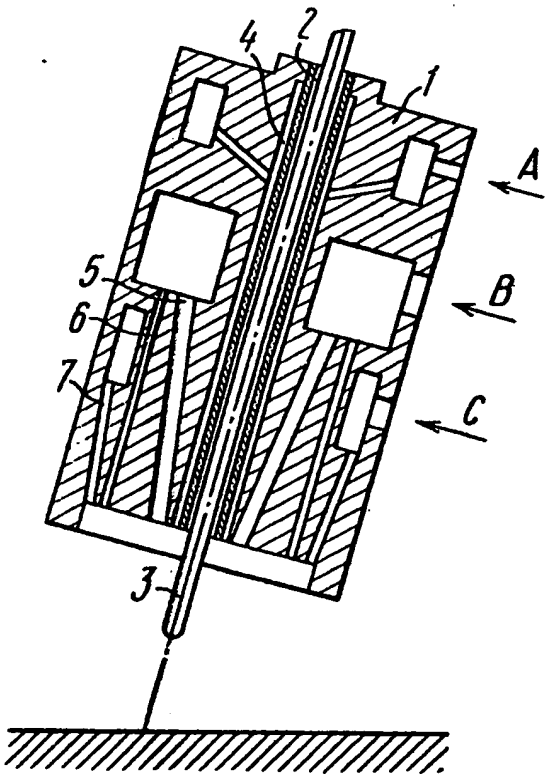

FIG. 1

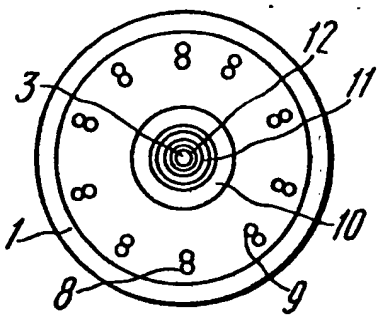

FIG. 2

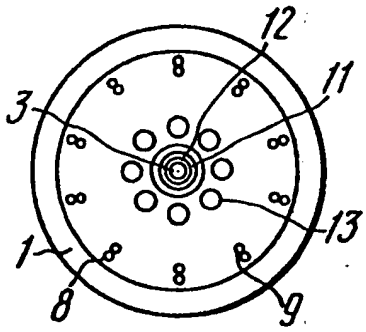

FIG. 3

SPECIFICATION

Method and apparatus for producing molten puddles during scarfing

The present invention relates to a method and apparatus for producing molten puddles in the course of scarfing.

The rolled metal is known to have all kinds of defects, such as slivers, cracks or hair-line cracks, etc. These flaws lead to a higher rate of metal consumption required for the manufacture of various products and adversely affect their quality.

An ever increasing volume of rolled stock production as well as stringent requirements imposed on the quality of metal call for the necessity to eliminate such defects.

What is required is a method and apparatus for producing a molten puddle on the surface of a metal workpiece being scarfed such that will make is possible to step up the scarfing reaction and to transfer the droplets of molten metal of wire with enhanced heating output to a preselected spot on said surface.

Thus the present invention provides a method for producing a molten puddle on the surface of a metal workpiece being scarfed, comprising the steps of igniting the fuel gas-oxygen mixture, heating a steel wire with the resultant flame, wherein, the wire is heated to a temperature of from 900 to 1,450°C, whereupon the hot wire is intermittently fed into a flow of scarfing oxygen with the resultant formation of droplets of molten metal to be transferred by the flow of scarfing oxygen on to the surface of the metal workpiece being scarfed.

As mentioned above, the steel wire is preferably heated to a temperature ranging from 900 to 1,450°C. Heating the wire below 900°C would substantially increase the wire melting time in the flow of scarfing oxygen which, in turn, will increase the time required for the puddle formation. Heating the wire above 1,450°C would result in the ignition of wire at an earlier stage before it is melted to form droplets of molten metal.

The temperature in the scarfing area is raised by virtue of the fact that the droplets of the wire molten metal start oxidizing in the course of their delivery to this area. Therefore, intermittent feeding of wire into the flow of scarfing oxygen, accompanied by the formation of molten drops, permits the wire melt to be effectively used for making an instantaneous thermochemical start on the surface of the metal workpiece. The substantially increases the amount of heat introduced per time unit into the scarfing area and, subsequently, permits the process of puddle formation to be stepped up.

By transferring the droplets of the wire molten metal to the scarfing area on the surface f a metal workpiece by the flow of scarfing oxygen, it becomes possible to ensure a high accuracy delivery of these droplets to the scarfing area. In addition, a thermochemical reaction caused by oxidation of the wire m It is permitted to start in the course of transportation of these drops to said area.

The wire is preferably introduced into th flow of scarfing oxygen to a depth equalling 0.5 to 1 time the diameter of this flow. If this value is less than 0.5 time the diameter of the scarfing oxygen flow, the mass of these drops and, consequently, the overall temperature in the scarfing area, as well as the amount of heat released during the thermochemical reaction and put per time unit into the scarfing area are insufficient for the molten puddle to be formed on the surface of a metal workpiece. With the wire feeding depth being more than one diameter of the scarfing oxygen flow, the method for producing a molten puddle turns out to be inefficient.

The steel wire, required for the formation of droplets of molten metal, is preferably fed in the flow of fuel gas, the latter being enveloped by the flow of scarfing oxygen directed at one point on the steel wire.

Such procedure of feeding the wire, fuel gas and scarfing oxygen gas makes it possible to increase the heating output of each droplet of the wire molten metal. This increase is explained by the fact that fuel gas is burnt in the oxygen which is not contaminated with the products of combustion.

Since the gas flame has a maximum temperature in its centre, a maximum amount of heating power is given up to the wire. As a result, the wire is melted at a faster rate, and the heat producing reaction in the resultant droplet of molten metal is accelerated.

As mentioned before, the delivery of droplets of the wire molten metal to the scarfing area on the surface of a metal workpiece by the flow of scarfing oxygen, directed at one point on the wire surface, permits the exothermic reaction to be stepped up. This, in turn, results in that a greater number of such droplets are fed per unit of the scarfing area, thereby enhancing the heating power transferred by a droplet of molten metal to produce a molten puddle on the surface of a metal workpiece.

The flow of scarfing oxygen is preferably formed by a plurality of jets. This makes is possible to discharge the products of combustion from the burning zone through the interspaces between the jets, thereby bringing down the rate of oxygen contamination with the combustion products and ensuring a high oxygen concentration in the oxygen scarfing flow.

The invention also provides apparatus for producing a molten puddle on the surface of a metal workpiece being scarfed, including a housing with ducts for feeding steel wire, oxygen, scarfing oxygen and a fuel gas, wherein, the housing has an additional duct for supplying a fuel gas, with th wire feeding duct being arranged inside the latter and coaxially th rewith, the duct for feeding scarfing oxygen being made in th form of an annular slot interposed between th additional duct for supplying a fu l gas and the oxygen supply duct so as to p rmit the flow of

scarfing oxygen to be directed at one point on the surface of steel wire, the fuel gas feeding duct extending around the periphery of said housing.

The annular slot for feeding scarfing oxygen is preferably divided over the circumference by partitions provided to separate the flow of scarfing oxygen into a plurality of jets. With the method of the invention for making instantaeous scarfing starts it takes only 0.05 to 0.08 sec to form a molten puddle. This renders the method and apparatus of the invention applicable to selective scarfing effected at the metal feeding rate of 0.35 m/sec. In addition, it becomes possible to produce the molten puddle and, consequently, to carry out the scarfing operation on the front edge of the metal workpiece under treatment.

The invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a general view, in longitudinal section, of apparatus for carrying into effect the method of the invention for producing a molten puddle on the surface of a metal workpiece;

FIG. 2 is a bottom view of apparatus according to the invention;

FIG. 3 is a bottom view of apparatus according to the invention.

A method for producing a molten puddle on the surface of a metal workpiece being scarfed can be easily carried into effect by means of appropriate apparatus well known to those skilled in the art.

A mixture of oxygen and a fuel gas, such as natural or coke gas, is fed to the apparatus housing provided with ducts for applying a fuel gas, oxygen, scarfing oxygen and wire. The fuel gas is fed under a pressure of 0.03 to 0.08 μPa, and oxygen is fed under a pressure of 0.12 to 0.16 μPa. The mixture of gases is ignited to produce a flame, with a 3 mm dia steel wire being introduced into the latter. The wire is heated to a temperature of 900 to 1,450°C, whereupon it is fed in a stepwise manner at a rate of 0.03 to 0.05 m/sec into a flow of scarfing oxygen fed under a pressure of 0.5 to 0.7 μPa. The end of wire is melted in the scarfing oxygen to form droplets of molten metal, which are then transferred by the flow of scarfing oxygen onto the surface of a metal workpiece being scarfed. In the course of delivery, the droplets of molten metal are oxidized to produce a thermochemical reaction. At the instant of contact with the work surface, the scarfing reaction is immediately initiated and a molten puddle is formed at a preselected spot on said surface.

As mentioned before, the hot wire is preferably fed into the flow of scarfing oxygen to a depth equalling 0.5 to 1 time the diameter of scarfing oxygen flow.

The invention will be further illustrated by the following Examples.

EXAMPLE 1

Fed into a housing through respective ducts formed therein were natural gas, oxygen and steel wire 3 mm in dia. Natural gas was fed under a pressure of 0.05 μPa and oxygen under a pressure of 0.12 μPa. The resultant mixture was ignited, thereby heating up the wire to a temperature of 1200°C. The hot wire was then fed in a stepwise manner into the flow of scarfing oxygen to a depth equalling 0.5 time the diameter of this flow. The end of wire introduced into the flow was melted to form droplets of molten metal, which were transferred by the scarfing oxygen flow onto the surface of a metal workpiece, thereby causing an immediate scarfing reaction to begin and a molten puddle to form at a preselected spot on said surface. The puddle formation time was 0.9 sec.

EXAMPLE 2

Natural gas, oxygen and steel wire was fed into a housing through respective ducts formed in the housing of a scarfing machine. The resultant fuel mixture was ignited, thereby heating up the wire to a temperature of 900°C. The hot wire was then fed in a stepwise manner into the flow of scarfing oxygen to a depth of one diameter of this flow. The wire end introduced into the flow was melted to form droplets of molten metal, which were transferred onto the surface of a metal workpiece, thereby causing an immediate scarfing reaction to begin and a molten puddle to form a preselected spot on said surface. The puddle formation time was 0.8 sec.

The method of the invention may be variously otherwise embodied by means of the apparatus shown in FIGS. 1, 2 and 3.

The apparatus, illustrated in FIG. 1, includes a housing 1 having a central duct 2 for feeding a wire 3, an additional duct 4 for feeding a fuel gas, which is arranged coaxially with the wire feeding duct 2, a duct 5 for feeding scarfing oxygen, which is made in the form of a tapered annular slot, a duct 6 for feeding oxygen, and a duct 7 for feeding a fuel gas. The oxygen feeding duct 6 is arranged in parallel relationship with the duct 2 for feeding the wire 3, and the fuel gas supply duct 7 is arranged at an angle to the lower end face of the housing 1.

FIG. 2 is a bottom view of the apparatus shown in FIG. 1. Thus FIG. 2 illustrates mutual arrangement and shapes of outlets 8 and 9 of the respective ducts 7 and 6, shown in FIG. 1, an outlet 10 of the duct 5, shown in FIG. 1, an outlet 11 of the duct 4, shown in FIG. 1, and an outlet 12 of the duct 2, shown in FIG. 1, for feeding the wire 3. The outlets 8 and 9 of the ducts 7 and 6 are ring-shaped and are arranged over concentrical circumferences. The outlet 10 of the duct 5 is made in the form of an annular slot, with the centre of the outlet 12 of the duct 2 being arranged on its axis.

FIG. 3 is a bottom view of the apparatus according to the invention, in which the duct 5 for feeding scarfing oxygen is divided by partitions over its periphery so that openings 13 are formed between these partitions. Shown in FIG. 3 is a mutual arrangement and shapes of the outlets 8 and 9 with respect to the ducts 7 and 6, shown in FIG. 1, the outlets 13 of the duct 5, shown in FIG.

1, the outlet 11 of the addition duct 4, shown in FIG. 1, and the utlet 12 of the wire feeding duct 2, also shown in FIG. 1.

Th outlets 8, 9 and 13 of the ducts 7, 6 and 5, shown in FIG. 1, are annular in shape and are arranged over three concentrical circumferences. The outlets 11 and 12 of the ducts 4 and 2 are arranged concentrically. The outlet 12 of the duct 2 is arranged in the centre of the three above-mentioned concentrical outlets 8, 9 and 13.

The method according to the invention is carried into effect by means of the above-described apparatus as follows.

EXAMPLE 3

Coke, gas, oxygen and coke gas are fed into the housing 1 respectively in the direction of arrows A, B, C (FIG. 1). Coke gas is fed from the housing 1 through the outlets 11 and 8 (FIG. 2) along the additional duct 4 and the duct 7, and oxygen is fed along the ducts 5 and 6 (FIG. 1) through the outlets 10 and 11 (FIG. 2). Coke gas is fed under a pressure of 0.03 μPa and oxygen is fed under a pressure of 0.05 μPa. The resultant gas mixture is ignited to produce a heating flame into which a 3 to 4 mm dia steel wire shown at 3 in FIG. 1, is fed along the duct 2 (FIG. 1) through the outlet 12 (FIG. 2). The wire 3 is heated to a temperature of 900°C, whereupon a flow of scarfing oxygen under a pressure of 0.5 μPa is fed along the duct 5 (FIG. 1) through the outlet 10 (FIG. 2). Next, the wire 3 (FIG. 1) is fed in a stepwise manner into the flow of scarfing oxygen at a rate of 0.03 m/sec. The end of the wire 3 is melted in the flow of scarfing oxygen to produce droplets of molten metal, which are then transferred by the flow of scarfing oxygen onto the surface of a metal workpiece, thereby causing an immediate scarfing reaction to begin and a molten puddle to form at a preselected spot on said surface. The puddle formation time is 0.08 sec.

EXAMPLE 4

Natural gas, oxygen and natural gas are respectively fed into the housing 1 in the direction of arrows A, B, C (FIG. 1). Natural gas is fed from the housing 1 along the ducts 4 and 7 (FIG. 1) through the outlets 11 and 8 (FIG. 3), and oxygen is fed along the ducts 5 and 6 (FIG. 1) through the outlets 13 and 8 (FIG. 3). Natural gas is fed under a pressure of 0.08 μPa and oxygen is fed under a pressure of 0.16 μPa. The resultant gas mixture is ignited to produce a heating flame into which a 4 mm wire, shown at 3 in FIG. 1, is fed along the duct 2 (FIG.1) through the outlet 12. Next, the wire 3 is heated to a temperature of 1,450°C, whereupon a flow of scarfing oxygen is fed under a pressure of 0.7 μPa along the duct 5 (FIG. 1) through the utlets 13 (FIG. 3). Thereafter, the wire 3 is fed in a st pwise mann r into the flow of scarfing oxygen at a rat of 0.05 m/sec. The end of the wire 3 is melted in the flow of scarfing oxygen to produce droplets of molten metal, which are transferred by this flow onto the surface of a metal workpiece, thereby causing a thermoch mical reaction to begin in the process of delivery of these droplets and a molten puddle to form on contact with the metal surface at a preselected spot thereof.

The combustion products are discharge from the burning zone through the interspaces between the oxygen jets fed along the ducts 5 (FIG. 1) through the outlets 13 (FIG. 3). The puddle formation time was 0.03 sec.

CLAIMS

1. A method for producing a molten puddle on the surface of a metal workpiece being scarfed, comprising the steps of igniting the fuel gas-oxygen mixture; heating a steel wire with the resultant flame to a temperature of from 900 to 1,450°C; feeding the wire in a stepwise manner into a stream of scarfing oxygen with the resultant formation of droplets of molten metal on said wire; transferring said droplets of molten metal onto the surface of the metal workpiece being scarfed.

2. A method as claimed in claim 1, wherein the hot wire is fed into the flow of scarfing oxygen to a depth equalling 0.5 to 1 time the diameter of this flow.

3. A method as claimed in claim 1, wherein the hot wire is introduced into the flow of scarfing oxygen in a flow of fuel gas disposed in the scarfing oxygen flow, the latter being directed so as to strike the surface of steel wire at one point thereof.

4. A method as claimed in claim 3, wherein the flow of scarfing oxygen is formed by a plurality of jets.

5. Apparatus for carrying out the method of the invention as claimed in claim 3, comprising a housing having ducts for feeding steel wire, oxygen, scarfing oxygen and a fuel gas; said housing having an additional duct for feeding a fuel gas wherein is coaxial arranged the duct for feeding steel wire; the scarfing oxygen feeding duct being made in the form of a tapered slot interposed between the additional duct for feeding a fuel gas and the oxygen feeding gas; the duct for feeding scarfing oxygen being made so as to permit the flow of scarfing oxygen to strike the surface of steel wire at one point thereof, and the duct for feeding a fuel gas being formed in the housing around its periphery.

6. The apparatus as claimed in claim 5, wherein the annular slot is divided around the circumference by partitions provided to separate th flow of scarfing oxygen into a plurality of j ts.

7. A method for producing a molten puddl on the surface of a m tal workpi ce being scarfed,

substantially as described above and illustrated by Examples 1—4.

8. Apparatus for producing a molten metal on th surface of a metal workpiece being scarfed, substantially as described above with reference to, and as sh wn in, the accompanying drawings.

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